January 1999

COMMON PARASITES, DISEASES AND INJURIES OF FRESHWATER FISHES IN THE NORTHWEST TERRITORIES AND NUNAVUT

D. B. Stewart

L. M. J. Bernier

COMMON PARASITES, DISEASES AND INJURIES OF FRESHWATER FISHES IN THE NORTHWEST TERRITORIES AND NUNAVUT

Fisheries and Oceans   Pêches et Océans

Canada

Map of the Northwest Territories and Nunavut

Cover photo and map credit D.K. McGowan

Copies of this brochure are available from Department of Fisheries and Oceans (DFO) offices in the Northwest Territories and Nunavut, or from DFO Central and Arctic Region, 501 University Crescent, Winnipeg, MB, R3T 2N6.

COMMON PARASITES, DISEASES AND INJURIES OF FRESHWATER FISHES IN THE NORTHWEST TERRITORIES AND NUNAVUT

by

D.B. Stewart and L.M.J. Bernier

Prepared by Arctic Biological Consultants, Winnipeg, for the Department of Fisheries and Oceans, Central and Arctic Region.

1999

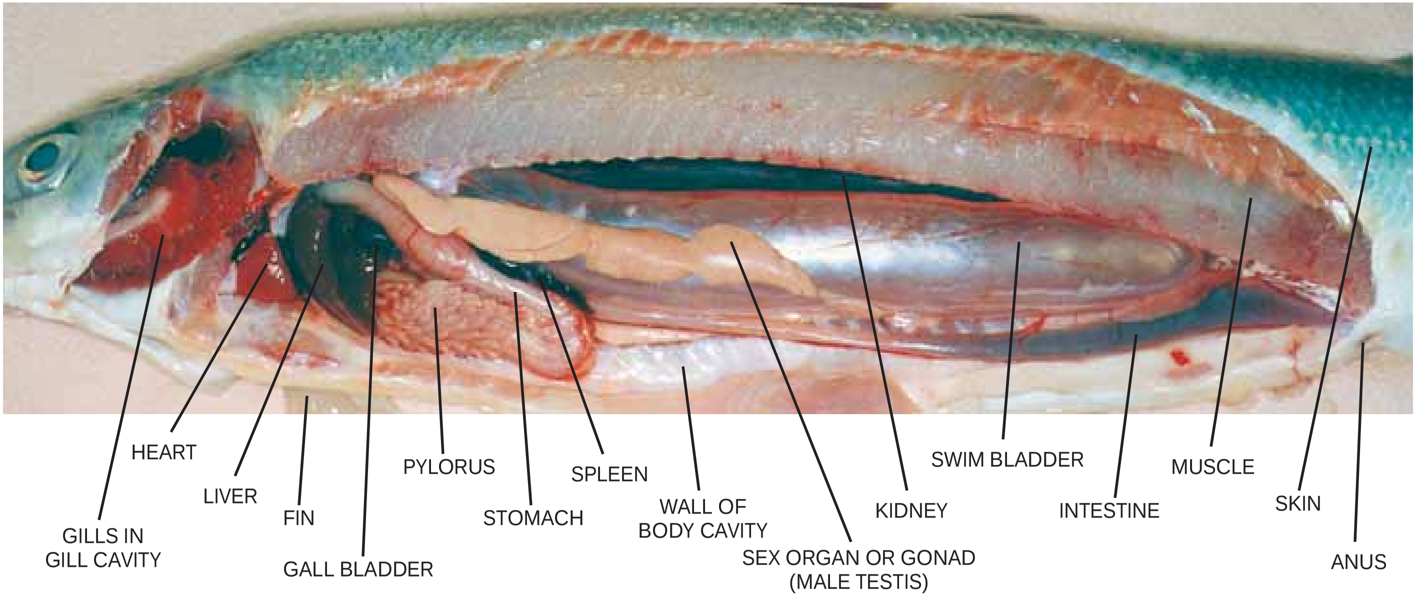

Figure 1. Photo showing fish organs (photo credit L.M.J. Bernier).

INTRODUCTION

This booklet gives basic information on common parasites, diseases and injuries of fish harvested from fresh water in the Northwest Territories and Nunavut. It answers some of the more common questions asked by Aboriginal, domestic, sport and commercial harvesters, and by fisheries researchers. It is not an in-depth treatment of fish health. Parasites that are uncommon or too small to be seen with the naked eye and diseases that are poorly known are not discussed. Relatively little research has been conducted on fish parasites in the region, less still on fish diseases and injuries.

To use this booklet to find information on a parasite, you need to know where in the fish it was found (see Figure 1 opposite) and the type of fish. Using this information, you can look up the names of likely parasites in the table on the next page. A parasite in the mouth of an Arctic charr, for example, may be from the Class Crustacea and genus *Salmincola* (see highlighted example in table). Information on the parasites follows the table. It is organized alphabetically by class and then by genus. For each genus, the type of fish carrying the parasite(s), the site(s) of infection or attachment, and basic biology of the species are described, and often illustrated. The relationships between these parasites and people are discussed in the next section. Following the parasite descriptions, the causes of some common fish diseases and injuries are described and visible symptoms or characteristic injuries are illustrated.

These descriptions are followed by a section on how to preserve specimens and where to send them for identification, a glossary that explains words that are highlighted when they first appear in the text, a list of the key sources of information used for the brochure, and a list of the Latin and common names of the fish.

LOCATION ON or IN FISH	INVERTEBRATE PARASITE (* larval forms; M = marine) CLASS	Genus
eyes	TREMATODA	*Diplostomum**
fins	CRUSTACEA	*Salmincola*
	HIRUDINEA	*Piscicola*
skin	CRUSTACEA	*Coregonicola* (M)
	HIRUDINEA	*Piscicola*
gills and gill cavity	CRUSTACEA	*Salmincola*
	HIRUDINEA	*Cystobranchus*
		Piscicola
	MONOGENEA	*Discocotyle*
		Tetraonchus
mouth	CRUSTACEA	*Salmincola*
	HIRUDINEA	*Piscicola*
body cavity	CESTODA	*Diphyllobothrium**
	NEMATODA	*Philonema*
gut surface (i.e. viscera)	CESTODA	*Diphyllobothrium**
		*Triaenophorus**
	NEMATODA	*Contracaecum**
		*Raphidascaris**
inside stomach, pylorus or intestine (i.e. gastro-intestinal tract)	ACANTHOCEPHALA	*Corynosoma** (M)
		Echinorhynchus
		Neoechinorhynchus
	CESTODA	*Bothrimonus* (M)
		Bothriocephalus
		Cyathocephalus
		Eubothrium
		Glaridacris
		Proteocephalus
		Triaenophorus
	NEMATODA	*Haplonema*
		Hysterothylacium
		Raphidascaris
		Truttaedacnitis
	TREMATODA	*Brachyphallus* (M)
		Crepidostomum
gall bladder	NEMATODA	*Hysterothylacium*
	TREMATODA	*Crepidostomum*
sex organs (gonad)	NEMATODA	*Philonema*
heart, kidney	TREMATODA	*Icthyocotylurus**
liver	CESTODA	*Triaenophorus**
	NEMATODA	*Philonema*
		*Raphidascaris**
swimbladder	NEMATODA	*Cystidicola*
		Hysterothylacium
		Philonema
		*Raphidascaris**
muscle	CESTODA	*Diphyllobothrium**
		*Triaenophorus**

Arctic charr	Arctic cisco	Arctic grayling	broad whitefish	burbot	inconnu	lake cisco	lake trout	lake whitefish	least cisco	longnose sucker	northern pike	round whitefish	yellow walleye
		●	●					●	●				
●	●		●				●	●	●				
			●		●		●	●					
			●					●					
			●				●						
●		●	●		●	●	●	●					
				●									
			●		●			●					
			●			●							
●			●										
●				●									
				●									
●	●		●				●	●	●				
●						●	●		●		●		
●	●		●			●	●	●	●				
		●						●					
				●									
			●	●				●	●				
●				●									
●	●	●	●			●	●	●	●				
●		●							●	●			
●	●						●	●					
								●					●
●		●	●				●	●	●				
●				●	●	●	●						
										●			
●	●		●		●	●	●	●	●		●		
											●		●
				●									
●							●		●				
											●		
			●										
●	●		●						●				
●			●				●		●				
							●		●				
●			●				●	●	●				
									●				
			●					●	●				
				●									
●													
				●				●	●				
●			●				●	●					
							●						
●							●				●		
			●										
											●		●
		●	●		●	●	●	●	●			●	

PARASITES

A parasite is an animal that lives in or on another animal from which it gets its food. Classes of invertebrate parasites are discussed in alphabetical order as follows:

- Acanthocephala (spiny-headed worms)
- Cestoda (tapeworms)
- Crustacea
- Hirudinea (leeches)
- Monogenea (flat worms)
- Nematoda (round worms)
- Trematoda (flukes)

Lampreys are the only vertebrate parasite of freshwater fishes in the Northwest Territories and Nunavut. They are discussed last.

The fact that few parasites have been reported from some fish, such as longnose sucker and round whitefish (see Table), does not mean that they are “cleaner” than other fishes. It means, instead, that few have been examined for parasites. The effects of fish parasites on people are summarized at the end of this section.

ACANTHOCEPHALA (spiny-headed worms)

Acanthocephalans are parasites that live in the intestines of many fish species world wide. Representatives belonging to the genera *Echinorhynchus* and *Neoechinorhynchus* are fairly common in salmonid fishes (see Glossary) in the Northwest Territories and Nunavut (see Table). Larvae of a small marine species, *Corynosoma strumosum*, have been found in burbot in the Mackenzie River. This species matures into adults in seals. The genus also infects Arctic charr on Melville Peninsula.

Fish get *Echinorhynchus* by eating amphipods (e.g. *Gammarus;* Figure 2) that contain the parasite larvae, and *Neoechinorhynchus* by eating ostracods that have the parasite larvae. When the amphipods or ostracods are digested the larvae are released and develop into adults in the fish. The adult worms are found in the intestine and sometimes in the stomach or pylorus. They attach by embedding a spiny organ, the proboscis, into the tissue, where they cause local damage. Their eggs are released into the water with the fish's feces, where they can be eaten by amphipods or ostracods and repeat the cycle. **These parasites do not infect humans or dogs, or affect the value or edibility of fish.**

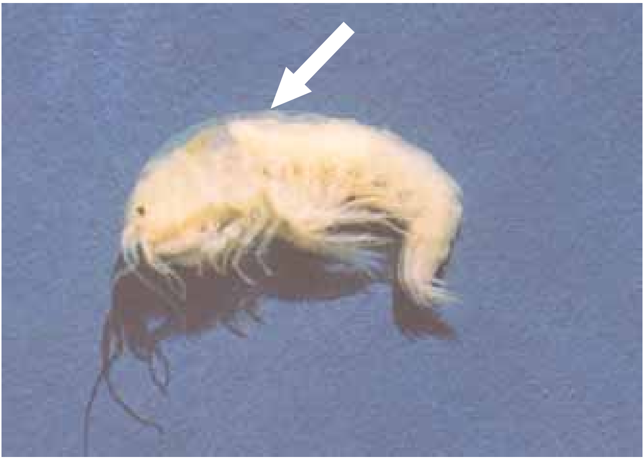

Figure 2. *Echinorhynchus salmonis* larva (see arrow) in an amphipod, *Gammarus lacustris*, from a lake trout stomach (photo credit L.M.J. Bernier).

Echinorhynchus: Three species of this genus have been reported from the region. *Echinorhynchus gadi* is a marine parasite that infects anadromous salmonids. Its presence indicates that a fish has fed on marine invertebrates. *Echinorhynchus leidyi* and *E. salmonis* are common in fresh water salmonids. They are 10 to 30 mm (½ to 1¼ in.) in length and attach to the inner surface of the intestine (Figure 3). Heavy infections are not unusual and an Arctic charr can have over 800 worms in its intestine.

Figure 3. Adult *Echinorhynchus salmonis* attached to the inside of a lake trout intestine (photo credit L.M.J. Bernier).

Neoechinorhynchus: The only species of this genus that has been identified from the region is *N. rutili*. It is smaller than *Echinorhynchus*, up to 7 mm in length, and has been found in Arctic charr and least cisco. The genus has also been found in broad whitefish.

CESTODA (tapeworms)

Tapeworms are widely distributed but individual species often infect only a few fish species. Like the acanthocephalans, they are internal parasites with an indirect life cycle. This means that they pass through a number of larval stages, each in a different host species, before maturing into adults. Where fish are the final hosts, the white, segmented, ribbon-like adult worms attach themselves to the inside of the intestine, pylorus, or stomach using suckers or hooks on their front end. There they absorb food through the body surface, and in large numbers can block the digestive tract and cause the fish to starve. Each of their segments (proglotids) contains a complete set of reproductive organs. When a segment breaks off it passes down the digestive tract into the water where it breaks apart, releasing eggs to repeat the cycle.

Representatives of the genera *Bothrimonus*, *Cyathocephalus*, *Diphyllobothrium*, *Eubothrium*, *Proteocephalus*, and *Triaenophorus* are common in freshwater fish species in the Northwest Territories and

Nunavut (see Table). *Bothriocephalus cuspidatus* has been found in yellow walleye in Great Slave Lake. The genus has also been found in the lake whitefish. *Glaridacris catostomi* has also been found in the intestine and stomach of longnose sucker. **Some tapeworm larvae can infect people and/or dogs. They also affect the health and value of infected fishes. Two species of *Diphyllobothrium* can infect humans.**

Bothrimonus: This marine tapeworm is included here because it infects a variety of salmonids from the region. These fish get *B. sturionis* when they eat marine amphipods that contain the larvae. These amphipods are easy prey as they are sluggish and float to the surface once infected. The larvae mature into adults in the fish and attach to their intestines. An individual charr can have over 450 adult worms. Because the fish lose these worms when they enter fresh water and become re-infected when they return to sea, this parasite is a useful short-term indicator of an anadromous (searun) lifestyle. Anadromous Arctic charr often trail long strings of *B. sturionis* from their anus as they migrate up freshwater streams in the fall.

Cyathocephalus: This tapeworm, *C. truncatus*, is widely distributed in the region but not common. It infects fish on the mainland and on Victoria, Southampton, and Baffin islands. Arctic charr, lake trout, broad and lake whitefish, and least cisco are infected by eating amphipods that contain the larvae. The larvae mature into short (2-3 cm; ~1 in.) adult tapeworms with a large bell-shaped front end (scolex) that attaches to the intestines. Infected fish seldom have more than 25 adult worms. The genus has also been found in Arctic grayling.

Diphyllobothrium: Three species of this genus have been identified in the region, *D. dendriticum*, *D. ditremum*, and *D. latum*. The first two are common and infect salmonids, often in very high numbers (Figure 4). The distribution and frequency of occurrence of *D. latum* in the Northwest Territories and Nunavut is not well known.

Fish get *Diphyllobothrium* by eating planktonic copepods (e.g. *Cyclops*, *Diaptomus*) that are infected with the parasite larvae (procercoid). In the fish, *D. dendriticum* and *D. ditremum* develop into another larval form (plerocercoid) and migrate into the stomach wall and onto the viscera and walls of the body cavity where they become enclosed within pearl-like cysts (Figures 5+6). The larvae of *D. latum* migrate instead into the muscle tissue and do not encyst. *Diphyllobothrium* larvae are long-lived in the fish host and accumulate as the fish matures. Infections may contribute to loss of growth and in some instances are a direct cause of death. When the fish is eaten fish tissue and the cyst walls are digested, releasing the larvae. If the predator is not a suitable host for the parasite, the larvae are digested or passed. If the predator is another suitable fish host the larvae will re-encyst; if it is a suitable bird or mammal host they will mature into adult tapeworms in the host's intestine.

The larvae of *D.dendriticum* are typically longer, up to 5 cm (2 in.) long, but much less numerous than those of *D. ditremum* which are about 1 cm (½ in.) long. Heavy infections of over 5,000 encysted larvae per fish are not uncommon in Arctic charr, particularly on Baffin Island where cannibalism provides the pathway to massive worm infections. These fish look healthy but are sluggish, soft, and flavourless. Their internal organs are often attached to one another and to the body wall by masses of cysts and scar tissue. *Diphyllobothrium latum*, the broad or fish tapeworm, infects northern pike and yellow walleye.

Both *D. dendriticum* and *D. latum* will infect humans and dogs. The former is short-lived in humans; the latter is longer lasting but readily treated; neither is life threatening. The cysts of *D. dendriticum* are not normally found in fish muscle. The larvae of *D. latum* are found living free in the muscle of northern pike and yellow walleye, often immediately under the skin. They can be killed by thorough cooking, or freezing to -21°C. Smoking the fish does not kill the parasite.

Figure 4. Pearl-like cysts of *Diphyllobothrium* larvae on the stomach of an Arctic charr. Do not eat these cysts raw (photo credit L.M.J. Bernier).

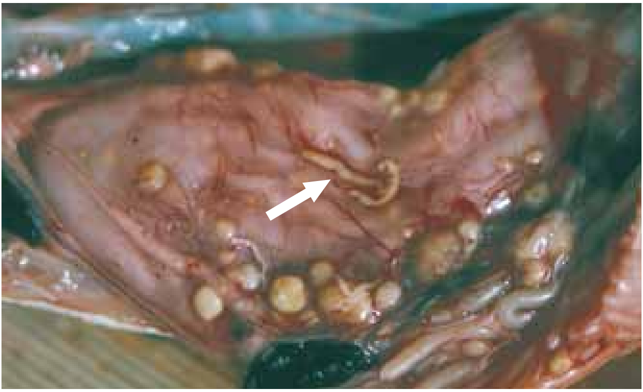

Figure 5. *Diphyllobothrium* larvae encysted and free (see arrow) on the stomach of an Arctic charr (photo credit D.B. Stewart).

Figure 6. *Diphyllobothrium* larvae encysted on the swimbladder of an Arctic charr (photo credit D.B. Stewart).

Eubothrium: These tapeworms are relatively common as adults in the intestine and pylorus of northern salmonids. Individual fish can have over 300 of the worms which can grow to 40 cm (16 in.) in length. Three species have been identified from the region, *E. crassum* in Arctic charr, *E. rugosum* in burbot, and *E. salvelini* in Arctic charr and lake trout (Figure 7). The genus has also been identified from inconnu and lake cisco.

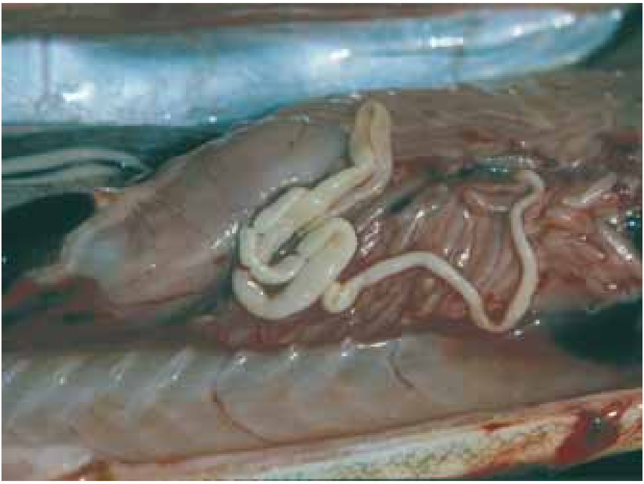

Figure 7. Adult tapeworm, *Eubothrium salvelini*, partly removed from the intestine of a lake trout. (photo credit D.B. Stewart).

Proteocephalus: These parasites are common and often numerous in fishes of the region, which can have over 700 of the adult worms. These tapeworms are thin compared to *Eubothrium*, and they vary in length from a few centimeters in cisco to over 10 cm (4 in.) in Arctic charr. Four species infect the intestines of fishes in the region: *P. arcticus* in Arctic charr, lake trout and least cisco; *P. exiguus* in least cisco; *P. longicollis* in Arctic charr; and *P. pinguis* in northern pike. The genus has also been found in the intestines and pylorus of Arctic cisco, inconnu, lake cisco, and lake whitefish.

Triaenophorus: Three species of this genus have been identified from fishes in the region. Fish get the parasite by eating copepods (e.g. *Cyclops*) that contain the larvae (procercoids)(Figure 8). In the fish, the larvae develop into another larval form (plerocercoid) which can cause considerable damage as it migrates from the stomach to the muscle or other organs (Figure 9). Larvae of *T. crassus* encyst in the muscle of a variety of salmonids (see Table), while those of *T. nodulosus* encyst on the gut of Arctic grayling and in the liver of burbot. The white cysts are common in the flesh of whitefish in lakes on the southern and western mainland of Nunavut and

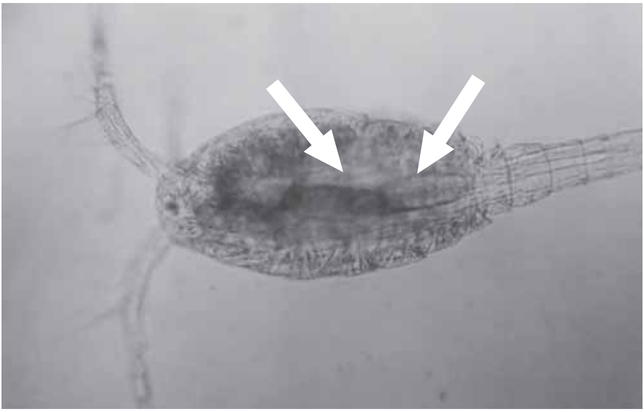

Figure 8. Copepod infected with *Triaenophorus crassus* larval procercoids (see arrows) magnified many times (photo credit G.H. Lawler).

Figure 9. *Triaenophorus crassus* larval plerocercoid encysted in whitefish muscle (photo credit G.H. Lawler).

Figure 10. *Triaenophorus crassus* attached to the intestine of a northern pike (photo credit D.B. Stewart).

the Northwest Territories. Larvae inside the cysts are thin, ribbon-like worms several centimetres in length. Cysts in the flesh lower the value of the fish to harvesters. Adults of both parasites infect the intestine and pylorus of northern pike that have eaten fish infected with the larvae (Figure 10). Adults of *T. stizostedionis* infect the intestine of yellow walleye. These adult tapeworms can cause considerable damage at the site of attachment, and in large numbers can block the intestine.

CRUSTACEA

Two genera of copepod crustaceans infest fish in the Northwest Territories and Nunavut, *Coregonicola* which infest anadromous whitefish in the marine environment, and *Salmincola* which are common and infest many northern freshwater fishes. Neither parasite has an intermediate host (direct life cycle). The wounds they create at their site of attachment can promote secondary bacterial or fungal infections that may kill the fish. **These parasites do not infest humans or dogs but can affect the health and value of infested fish.**

Coregonicola: These thin, white copepods are up to 10 cm (4 in.) long and trail along the sides of infested fish (Figure 11). To hold themselves in place, they burrow through the skin and secrete an anchor, or bulla, into the muscle (Figure 12). There is a raw wound at the skin surface that decreases the harvest value of the fish. *Coregonicola orientalis* infests anadromous lake

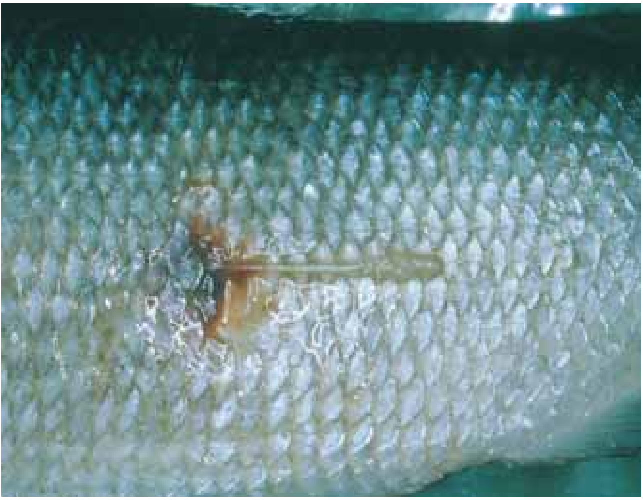

Figure 11. Adult female *Coregonicola orientalis*, without egg sacs, attached to a lake whitefish (photo credit J.D. Reist).

Figure 12. *Coregonicola orientalis* from a lake whitefish. Note large star-shaped bulla (photo credit L.M.J. Bernier).

whitefish, and *C. productus* broad whitefish. Neither marine parasite is common or numerous.

Salmincola: The genus *Salmincola* has a circumpolar distribution and its members are relatively common on salmonids in the region. Seven species infest these fish. *Salmincola carpionis* attach to the mouth of Arctic charr (Figure 13); *S. corpulentus* to the gills of lake cisco and broad and lake whitefish; *S. edwardsii* to the gills of Arctic charr and lake trout, and rarely to the fins of Arctic charr (Figure 14); *S. extensus* to the fins of Arctic and least cisco and lake and broad whitefish; *S. lotae* to the mouth of burbot; *S. nordmanni* to the gills of

Figure 13. *Salmincola carpionis* in the mouth of an Arctic charr (photo credit L.M.J. Bernier).

inconnu; and *S. thymalli* to the gills of Arctic grayling and inconnu. *Salmincola* have free-swimming larvae that attach themselves to the outer surface of the fish. These larvae move and shed (molt) their outer surface several times before maturing to adults. During the final larval stage the larger female attaches itself permanently to the fish using a large, circular anchor or bulla. Sexual reproduction occurs during this stage

Figure 14. *Salmincola edwardsii* on the gills of an Arctic charr. (photo credit D.B. Stewart).

or as an adult. The tiny male then disappears, and the female remains to feed on gill and/or skin tissue and to shed eggs into the water from her two egg sacs. The adult females are typically about a centimetre in body length. Heavy *Salmincola* infestations can lead to secondary infections that kill the fish. Some lake trout have over 50 *S. edwardsii* on their gills and Arctic charr over 20 *S. carpionis* in their mouths.

HIRUDINEA (leeches)

Parasitic leeches are blood sucking worms that have suckers at each end of their body and attach to the skin of fishes. Representatives of the genera *Cystobranchus* and *Piscicola* have been reported from fishes in the Northwest Territories. These leeches typically grow to about 3 cm (1¼ in.) in length. Depending upon their size and number they can take a relatively large blood meal, weakening the fish and creating a wound that may become infected. Heavy infestations may kill fish.

Cystobranchus: Adult *C. mammillatus* have been found on the gill cover (opercula) of burbot in the region.

Piscicola: Adult *P. milneri* have been found on the fins of broad whitefish, gills of burbot, fins and gills of inconnu, fins and skin of lake trout, and the gills and fins of lake whitefish in the region (Figure 15).

Figure 15. Preserved specimen of the leech *Piscicola milneri* (photo credit L.M.J. Bernier).

MONOGENEA (flatworms)

These small, flat worms hook onto the gills or skin of fish using an organ on their back end called a "haptor" which is studded with hooks or has a clamping arrangement of spines. Monogeneans have a direct life cycle with tiny free-swimming larvae (oncomiracidium). The adults, which parasitize fish, are typically less than a centimetre long and are seldom seen by the casual observer. Two species have been found in the Northwest Territories and Nunavut, *Tetraonchus alaskensis* from the gills of Arctic charr, and *Discocotyle sagitatta* from the gills of broad whitefish and cisco (likely lake cisco). The genus *Tetraonchus* has also been found on the gills of broad whitefish. Neither species is common or numerous, and both are small and seldom seen. **These parasites do not infest humans or dogs but can affect fish health.**

NEMATODA (round worms)

These transparent or white, unsegmented worms are widely distributed in freshwater fishes in the Northwest Territories and Nunavut. Common representative genera include *Cystidicola*, *Hysterothylacium*, *Philonema*, and *Raphidascaris*. They are found in the digestive tract, body cavity, swimbladder, gonads and liver. Most salmonids are infected by adult worms which cause limited tissue damage. Migrating larvae can cause considerable damage in many organs. *Contracaecum* and *Sterliadochona ephemeridarum* are marine nematodes that can infect anadromous Arctic charr but neither is common. In the Mackenzie River, some broad whitefish have *Truttaedacnitis alpinus* in their intestines and some burbot have marine *Contracaecum* and the freshwater nematode *Haplonema hamulatum*. **None of these round worms infect humans or dogs but they can affect fish health.**

Cystidicola: Adult threadworms are relatively common in the swimbladder of salmonids in the region. They are clear or white in colour and a few centimeters in length. Small numbers are not considered to affect the fish host, but fish with a severe infection may be feeble and skinny. *Cystidicola farionis* occurs in Arctic charr, lake trout, and broad and lake whitefish which typically have fewer than 10 worms. *Cystidicola stigmatura* occurs in Arctic charr and lake trout which can have over 3,500 worms (Figure 16). The parasites have similar life cycles. Adult worms in the swimbladder produce eggs which enter the fish host's digestive tract via the pneumatic duct. The eggs are then shed into the water. Those eaten by an amphipod or mysid intermediate host develop into larvae. If a fish host eats an infected amphipod or mysid, the larvae migrate into the swimbladder via the pneumatic duct and undergo a series of molts before maturing into adults.

Figure 16. Adult nematode, *Cystidicola stigmatura*, in the swimbladder of a lake trout (photo credit D.B. Stewart).

Hysterothylacium: This typically marine genus is of interest because one species, *H. aduncum,* has been found in an isolated freshwater lake on Melville Peninsula. There, the adults infect Arctic charr, lake trout and least cisco. One lake trout was parasitized by nearly 1,000 worms. The intermediate host for this parasite may be the fairy shrimp, *Mysis relicta*, a crustacean of marine origin which was isolated in the lake following glaciation. This may be the first parasite species in Arctic Canada to be identified as a marine glacial relict. *Mysis relicta* has also been found in other lakes on Victoria Island and on the northeastern mainland where *H. aduncum* parasitizes Arctic charr and lake trout.

Philonema: Adult members of this genus are found in small numbers in the body cavity, swimbladder, or sex organs (gonads) of Arctic charr, lake trout, least cisco, and northern pike. Only one species, *Philonema agubernaculum,* has been identified from the region. This relatively large white worm, 20 cm long (8 in.) and 1-2 mm (1/16 in.) thick, resembles a thin loop of spaghetti (Figures 17-19).

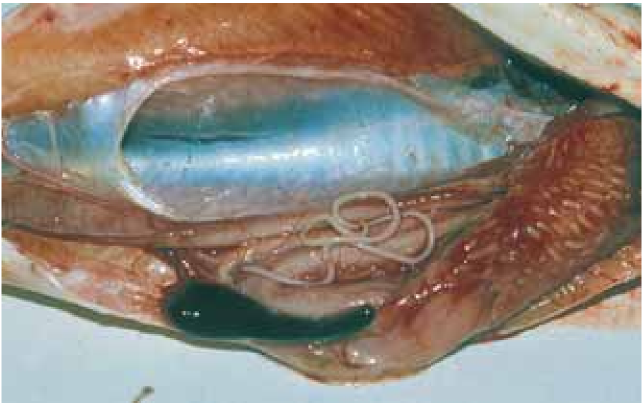

Figure 17. Adult nematode , *Philonema agubernaculum*, in the body cavity of an Arctic charr (photo credit D.B. Stewart).

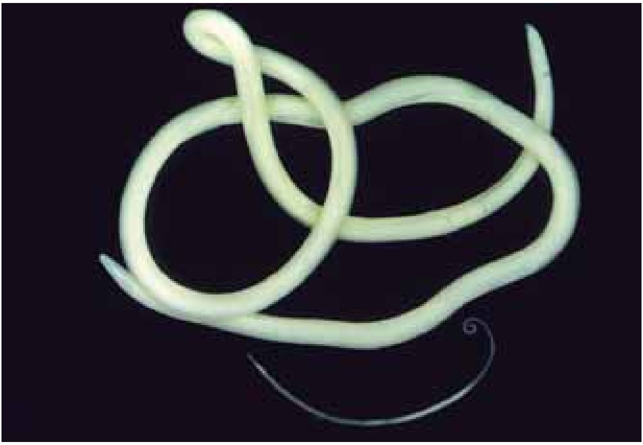

Figure 18. Adult female (large) and male (small) *Philonema agubernaculum* (photo credit L.M.J. Bernier).

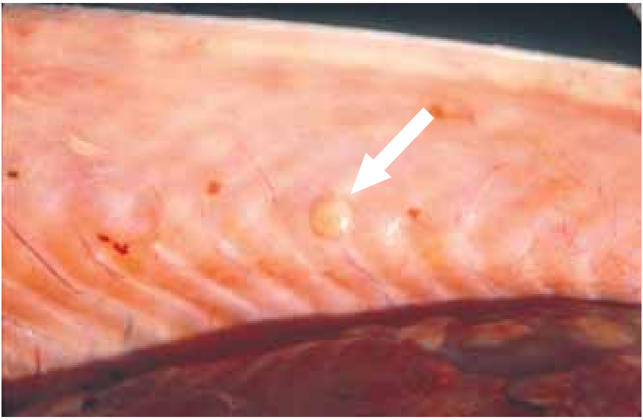

Figure 19. Larval nematode, *Philonema agubernaculum*, encysted on the body wall of an Arctic charr, see arrow (photo credit D.B. Stewart).

Raphidascaris: Only one species, *Raphidascaris acus*, has been identified from the region. Its larvae encyst on the stomach and pylorus of intermediate hosts including broad and lake whitefish, burbot and least cisco (Figure 20). The adult roundworms infect the intestines of northern pike which is a final host. Burbot are not a particularly good intermediate host so, instead of encysting on the digestive tract or swimbladder, the

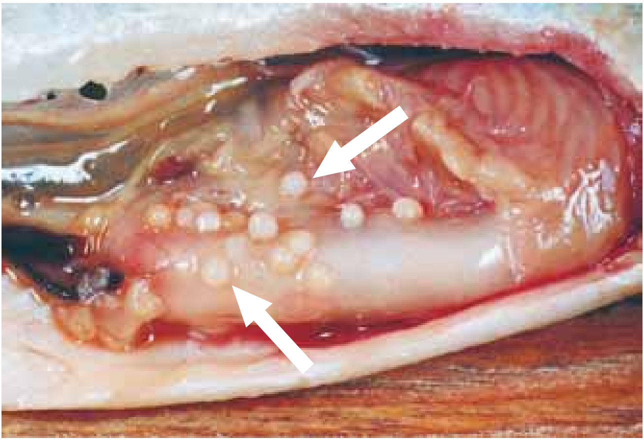

Figure 20. Cysts containing *Raphidascaris acus* (see arrows) and *Diphyllobothrium ditremum* on the stomach of a least cisco (photo credit D.B. Stewart).

worms migrate into the liver where they cause extensive damage (Figure 21). These infections have been found in burbot taken from the lower Mackenzie River. Cysts of *Raphidascaris* and *Diphyllobothrium* are often found on the same fish. The *Raphidascaris* cysts are perfectly round and tend to be smaller and harder. The larvae they contain are clear and very tiny.

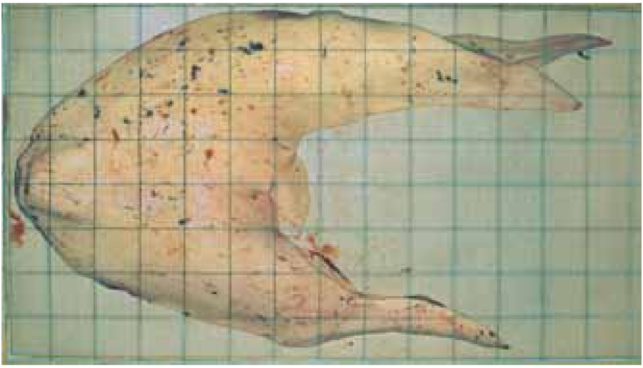

Figure 21. Liver of a burbot damaged (dark areas) by *Raphidascaris acus* larvae (photo credit L.M.J. Bernier).

TREMATODA (flukes)

These small parasites infect the internal organs of a variety of salmonids in the Northwest Territories and Nunavut. Their occurrence is likely widespread, geographically and in terms of fish species but, because of their small size, they are seldom seen. The adults attach to their hosts using suckers on their front end and belly (anterior and ventral surfaces). Representatives of the genera, *Crepidostomum*, *Diplostomum*, and *Icthyocotylurus* infect freshwater fishes in the region. They have an indirect life cycle with at least one intermediate host, typically a snail or clam. *Crepidostomum farionis* uses fingernail clams as its first intermediate host and develops to the adult stage in salmonids. Some least cisco in the western Arctic have up to 7,000 free-living larvae of *D. baeri bucculentum* in their eyes. These larvae develop into adults in gulls that eat the infected fish. Larvae (metacercaria) of *I. erraticus* form tiny cysts, usually on the heart, of least cisco and broad and lake whitefish in the western Arctic.

These larvae develop into adults in fish-eating birds. The marine fluke *Brachyphallus crenatus* is common in the stomachs of anadromous fishes that have recently returned from the sea. These fish become infected when they eat marine copepods that host the fluke larvae. Some of these fish have over 400 flukes in their stomach. **These parasites do not infect humans or dogs but can affect fish health.**

ARCTIC LAMPREY

Arctic lamprey, *Lampetra japonica*, occur in the Mackenzie Delta and River basin upstream into tributaries of Great Slave Lake and Artillery Lake (Figure 22). They migrate into the Slave, Hay, and perhaps other rivers to spawn. After hatching, the non-parasitic larvae (ammocoetes) may spend up to four years in the sediment of these rivers before emerging as adults and migrating into a large lake or brackish coastal waters. These primitive fish have a round sucking mouth. They use it to attach to the body surface of a variety of anadromous and fresh water fishes where they feed on blood and tissue. Their sharp teeth cause characteristic, circular wounds at the site of attachment, often with a light grey or white outer edge. Species in the region that are parasitized by Arctic lamprey include: Arctic charr, burbot, cisco, inconnu, lake trout, lake whitefish, longnose sucker, northern pike, and yellow walleye. Other species may also be damaged by Arctic lampreys. Wounds and scars caused by lampreys reduce the harvest value of a fish. Those that are parasitized for long periods become skinny and eventually die.

Figure 22. Head of an Arctic lamprey, *Lampetra japonica* (photo credit J. Johnson).

PARASITES AND PEOPLE

A professor told us how he has used the fact that most freshwater fish have parasites. When fishing is poor, he offers to clean the catch of a successful angler, explaining that he is a parasitologist and wishes to examine their fish. Most anglers never dream that their fine trout or yellow walleye have parasites and welcome his offer. Soon, he is showing them all sorts of disgusting worms. Appetites spoiled, they offer him their fish, which he accepts with a show of reluctance and then cooks for supper.

This story has two important messages about fish parasites: 1) that few of them infect people, and 2) that those that do can be killed by proper cooking or freezing to -21°C. A fish is properly cooked when the flesh is opaque and flakes easily. **Of the parasites reported from freshwater fish in the NWT and Nunavut, only larvae of the tapeworms *Diphyllobothrium dendriticum* and *Diphyllobothrium latum* infect people. Neither of these parasites is life-threatening and both are easy to get rid of.** The cysts of *D. dendriticum* occur on the gut surfaces of several fish species (see table). If they are eaten raw, the cysts walls are digested and the larvae emerge to mature into adult tapeworms in the intestine. These tapeworms are short-lived in humans. The white, thread-like larvae of *D. latum* that infect the muscle of northern pike and yellow walleye are sometimes seen by anglers. Eaten live, they too will mature into adult tapeworms in the intestine. These infections seldom produce symptoms, but some people may have mild intestinal upset. In rare cases, this worm causes anemia by depriving the person of vitamin B_{12}. Infections are diagnosed by examining the feces for tapeworm eggs, and are cured with drugs.

The effect of parasites on the value of the fish is perhaps greater than their impact on human health. Parasites can reduce the value of fish to harvesters by damaging the skin, infecting the meat, or spoiling the flavour or condition of the fish. People do not want to buy or eat fish with visible evidence of parasite infection—despite the fact that the parasite will not infect them. Consequently these fish are fed to dogs or wasted. Most of the economic damage is caused by tapeworm larvae. *Triaenophorus crassus* larvae infect the meat of several commercially harvested fish species, in particular lake whitefish. The Freshwater Fish Marketing Corporation pays less for infected fish than for those that are parasite free, since the parasites must be removed before the meat is sold. Heavy infections of *Diphyllobothrium* larvae are common in lake trout and non-anadromous Arctic charr. Some infected fish are skinny but others appear to be in good condition—neither has much harvest value. These fish do not fight when hooked, they are difficult and unpleasant to clean, their meat is soft and tasteless, and the parasites they carry can infect dogs. The presence of *Diphyllobothrium* larvae in inland charr stocks is one of the main reasons why harvesters concentrate their efforts on anadromous charr, which lose most of these parasites when they feed at sea in the summer.

Fish parasites also affect humans by reducing the condition of working dogs. Many northerners feed their dogs raw fish that host *Diphyllobothrium.* If the fish have not been cooked or frozen to kill the larvae, the larvae can develop into adult tapeworms in the dogs. These infections seldom kill a dog but can reduce its energy level. They are readily treated, and many trappers "worm" their dogs annually.

Parasites can also be useful. Some, such as *Bothrimonus*, indicate that a fish has fed at sea. This knowledge can help a fishery manager to assess the commercial harvest potential of an Arctic charr stock. Harvesters must take care not to transfer fish from one lake to another as this may introduce parasites that will harm fish in the receiving lake.

DISEASES

Large-scale fish kills are uncommon in the Northwest Territories and Nunavut. Most large-scale fish kills are caused not by disease but by freezing or lack of oxygen under the winter ice (winterkill). Unusually high summer water temperatures can weaken fish so that they become diseased and die. This happened to Arctic grayling in the upper Mackenzie River-Beaver Lake area in August 1989. If you observe a large scale fish kill please report it immediately to the nearest Department of Fisheries and Oceans (DFO) or GNWT Resources, Wildlife and Economic Development (RWED) office.

Diseases that affect freshwater fishes in the Northwest Territories and Nunavut are not known to affect humans, but diseased fish should not be eaten or fed to domestic animals. Few of these diseases have been studied in detail or over a broad geographical area. These brief descriptions of viral, bacterial and fungal diseases are based largely on personal communications from Ole Nielsen and Brian Souter of DFO in Winnipeg. It is important that harvesters do not transfer fish from one lake to another as this may introduce diseases that will harm fish in the receiving lake.

Bacterial kidney disease is caused by *Renibacterium salmoninarum*. It is a serious condition that affects

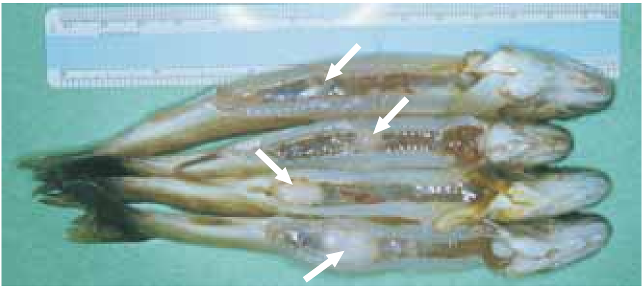

Figure 23. Hatchery fish with bacterial kidney disease, showing the typical greyish-white lumps on their kidneys, see arrows (photo credit DFO).

salmonids, causing skin damage ranging from small sores or pimples (spawning rash) to large abscesses under the skin. Affected fish are often dark, with enlarged bellies and bulging eyes. Bleeding may occur at the base of the fins. Damage in the muscle ranges from small red spots to large, deep, blood-tinged, fluid-filled abscesses. Damage in the body cavity is variable. In the most dramatic cases all of the internal organs contain variable sized, grayish white lumps and a clear or cloudy fluid may be present in the body cavity (Figure 23). In less dramatic cases, lumps may be seen in the heart, spleen or kidney, or behind the eye. The disease progresses slowly and can kill salmonid fishes.

"Bleach" disease is a bacterial disease that affects yellow walleye (Figure 24). It bleaches the skin pigments and makes the meat inedible. "Bleach" disease is usually associated with warm water and can kill fish.

Figure 24. Skin of a yellow walleye discoloured by "Bleach" disease (photo credit O. Nielsen).

Epidermal hyperplasia is caused by RNA tumor viruses which are specific to either northern pike or yellow walleye. It causes a thickening of the skin layer outside the scales (Figure 25). The disease is relatively common and affects up to 10% of the fish in some spawning runs. It does not kill the fish and disappears quickly following spawning as the water warms.

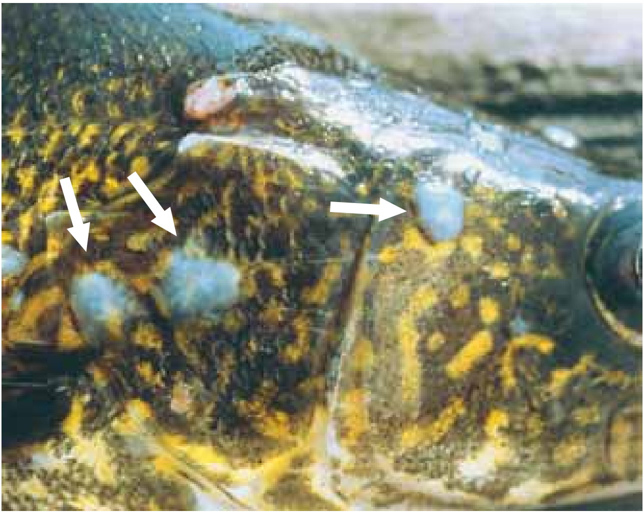

Figure 25. Patches of thick skin typical of epidermal hyperplasia on a yellow walleye, see arrows (photo credit O. Nielsen)

Lymphocystis is a viral disease that affects a number of fish species including yellow walleye. Infected cells grow in size until they are visible to the naked eye as lumpy white growths (Figure 26). The disease generally infects less than 1% of the fish. It progresses slowly and is seldom fatal to fish.

Figure 26. Enlarged cell growth typical of lymphocystis in yellow walleye (photo credit O. Nielsen).

Lymphosarcoma affects northern pike in the spring and early summer. It is caused by an RNA virus which causes a disease similar to leukemia in mammals. The virus causes red sores which can occur anywhere on the body and gives the scales a mushy consistency (Figure 27). It is probably spread by direct contact between fish during the spawning run. This disease is not common but is subject to local outbreaks. Lymphosarcoma does not affect humans but kills fish.

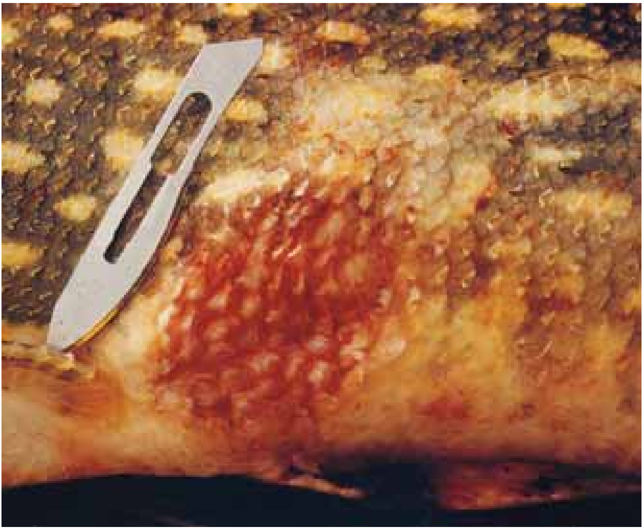

Figure 27. Red lymphosarcoma sore on a northern pike (photo credit O. Nielsen).

Myofibrogranuloma of yellow walleye is a condition comparable to muscular dystrophy in chickens and humans. Its cause is unknown and it is uncommon. The muscle fibers of affected fish waste away and become calcified, taking on a sandy appearance (Figure 28). This disease does not affect humans but normally kills fish.

Walleye dermal sarcoma is caused by an RNA tumor virus specific to yellow walleye. It causes skin tumors at or before spawning and can affect up to 10% of the fish in a population (Figure 29). The tumors seldom kill the fish and usually disappear in spring as the water warms, but some fish are affected into late summer and fall.

Figure 28. Myofibrogranuloma in the muscle of a yellow walleye (photo credit O. Nielsen).

Figure 29. Skin tumor typical of walleye dermal sarcoma (photo credit O. Nielsen).

Phoma herbarum is a fungus that normally lives on plants but can infect Arctic charr and other salmonids. Infected fish are unable to maintain their balance and cannot swim properly. The fungus can sometimes be seen on the skin of affected Arctic charr. It is thought to invade the fishes body with air taken into the swimbladder through the pneumatic duct. Early internal injuries are confined to the swimbladder and are small white areas in the front end of the organ. In more advanced cases the swimbladder fills with fungi and becomes enlarged. The wall is rapidly destroyed, leading to infection of other internal organs and extensive and acute inflammation or a chronic granulomatous reaction (Figure 30). The fungus is not easily spread to other fish. In outbreaks, it rarely kills more than 5% of the fish, generally affecting young fish.

Figure 30. Arctic charr infected with the fungus *Phoma herbarum* (photo credit DFO).

INJURIES

Some injuries to fishes in the Northwest Territories and Nunavut are characteristic of a particular type of trauma and easy to recognize. Three of these are the: 1) tear or puncture wounds caused by fish-eating birds or seals (Figure 31), 2) discoloured lines or cuts around the body

Figure 31. Healed scar on a broad whitefish (photo credit J.D. Reist).

Figure 32. Gillnet damage to an Arctic charr (photo credit D.K. McGowan).

of fish that have escaped gillnets (Figure 32), and 3) scraped bellies and fins of fish that have recently migrated along a shallow stream. Net hooks used by commercial fishermen and treble hooks used for snagging fish also cause a variety of scars or puncture wounds.

Odd-shaped fish are sometimes caught and reported to DFO. Their appearance can have many causes. A physical injury or severe change in temperature when the fish was in the egg or very young can produce fish that have a characteristic “stumpy” appearance (Figure 33). These fish have a number of back vertebrae that are squashed together but otherwise appear to be healthy (Figure 34).

Figure 33. Whitefish with a stunted appearance caused by the abnormal growth of its backbone (photo credit L. Harwood).

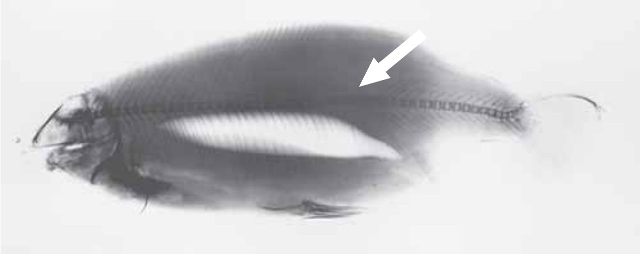

Figure 34. X-ray of the whitefish shown above. An arrow points to the abnormal vertebrae (photo credit DFO).

SPECIMEN PRESERVATION AND IDENTIFICATION

Fish parasites and diseases are best identified from intact fresh fish that are iced and delivered directly to the nearest Department of Fisheries and Oceans (DFO) office or to the DFO Fish Health Laboratory at 501 University Crescent, Winnipeg, MB, R3T 2N6 [Tel. (204) 983-5000]. Otherwise, a clear photograph of the affected area, a fresh frozen specimen, or a specimen preserved in alcohol or 10% formalin may be helpful. The photo or specimen must be properly labeled. The label should include your name and address and tell where the fish was caught (place name, map coordinates), the species of fish, location of the parasite in or on the fish, and the catch date.

PHOTOGRAPHS: If you have a camera, a clear, close-up photograph of the parasite or diseased tissue in the fish, and of the parasite removed from the fish and spread out to show its body and ends, may permit general identification.

FROZEN FISH: Most parasites and some diseases can be identified from fresh frozen fish, but tissue damage caused by freezing can make some identifications difficult. **If you send frozen specimens to DFO, please label them "KEEP FROZEN" and warn the receiver to expect them.**

PRESERVED SPECIMENS: Parasites and fish can be preserved in alcohol (tequila will do!) or formalin. This method of preservation can make it difficult to identify some parasites and diseases, since it kills bacteria and shrivels some parasites. Care must be taken if the parasites are removed from the fish as they are fragile and often strongly attached.

FIXATION: Good methods of preserving parasites for identification are:

Acanthocephala: Remove with attachment organ intact. Relax in ice water for 1-2 hours and then drain. If the proboscis is retracted place the worm on a glass slide under a cover slip. Add FAA (i.e. formyl acetic acid = 100 ml of 40% formalin, 500 ml of 95% ethanol, 20 ml of glacial acetic acid, 400 ml distilled water) while pressing gently on the cover slip to expose the proboscis. If the proboscis is exposed, add FAA and shake vigorously. Fix in FAA overnight. Store in 70% ethanol, changing occasionally.

Cestoda: Make sure to get the adult's tiny head. Relax in ice water for 1-2 hours, heat kill in water just below the boiling point while swirling them gently to stretch the worms to their full length, fix in FAA for at least 12 h, store in 70% ethanol which should be changed several times to remove the formalin.

Copepoda: Remove with attachment organ intact. Fix and store in 70% ethanol. It is important to wash parasites several times to remove attached debris—once fixed this debris is difficult to remove.

Monogenea and Trematoda: Relax in ice water for 1-2 hours, heat kill in water just below boiling point, fix in FAA for at least 12 h, store in 70% ethanol which should be changed several times to remove the formalin.

Nematoda: Do not wash them in water as some species fall apart. Fix in hot (not boiling) 70% ethanol**-- do not heat over an open flame.** Store in 70% ethanol or fix and store in 5% glycerine ethanol solution (i.e. 950 ml of 70% ethanol, 50 ml of glycerine).

Take care to handle the chemicals safely as directed by the manufacturer. Do not overheat the alcohol or breathe fumes, especially from the FAA. Special packing procedures may be required to meet shipping requirements for dangerous goods.

GLOSSARY

Amphipods are small shrimp-like animals that live in water and are important food for fish (see Figure 2).

Anadromous fish swim upstream from the sea to spawn in fresh water (e.g. searun Arctic charr).

Copepods are tiny animals that live in water and are important food for fish, some are parasitic on fish (see Figures 8, 11 & 13).

Crustaceans—see Amphipods, Copepods, Mysids, and Ostracods.

Cysts are sacs of tissue that a fish grows around a larval parasite to protect itself. The parasite is "**encysted**" in the fish.

Parasites with a **direct life cycle** do not have any intermediate hosts.

A **final host** is an animal that is infected by the adult form of a parasite.

The **host** is the animal that a parasite lives in or on.

Parasites with an **indirect life cycle** have an intermediate host.

An **intermediate host** is an animal that is infected by the larval, but not the adult, form of a parasite.

Internal parasites live inside the body of their host.

An **invertebrate** is an animal that has no backbone. Insects, worms, lobsters, and snails are examples of invertebrates.

Larvae are the young or immature form of a parasite. Some parasites have several larval stages between hatching from the egg and maturing into adults. Each stage can have a different host species.

A **life cycle** is the sequence of events in the life of a parasite from any one stage to the recurrence of that stage.

A **marine glacial relict** is a marine animal species that was isolated in a lake following glaciation and has adapted to live in fresh water.

Some parasite larvae **molt** or shed their outer surface several times before maturing to adults.

Mysids are known commonly as fairy shrimp.

Non-anadromous Arctic charr either cannot or choose not to feed at sea.

An **ostracod** is a tiny freshwater or marine animal with a "clam shell"-like cover.

The **pneumatic duct** is a tube that allows a fish to move air into, or gas out of, it's swimbladder.

The **pylorus** is the part of the digestive tract that separates the stomach from the intestine. In salmonid fishes it has many finger-like projections called pyloric caeca.

Salmonid fishes are those belonging to the Family Salmonidae which includes charr, cisco, grayling, inconnu, salmon, trout, and whitefish.

Viscera are the internal organs in the body cavity.

A **vertebrate** animal is one with a backbone.

REFERENCE LIST

Margolis and Arthur (1979) and MacDonald and Margolis (1995) have summarized the findings of most pre-1994 fish parasite studies in northern Canada. They are cited here as sources for references to that work. Some other studies that they did not cite are listed here. This booklet also contains information based on the author's studies of fish parasites across the Northwest Territories and Nunavut since 1981. During these studies over 7,500 fish were examined for parasites. Preserved specimens from these studies are housed at the National Museum of Natural Sciences in Ottawa and in the collection of L.M.J. Bernier. Studies of fish diseases in the Northwest Territories and Nunavut are few. General background references are marked with an asterisk (*).

BERNIER, L. M. J. 1985. Metazoan parasites of coregonids from Tuktoyaktuk Peninsula, Northwest Territories. Arctic Biological Consultants, Winnipeg, MB for Department of Fisheries and Oceans, Winnipeg, MB. iv + 61 p.

BERNIER, L. M. J. 1986. Liver pathology of burbot *Lota lota* (Linnaeus) and the parasites *Raphidascaris acus* (Bloch) and *Triaenophorus nodulosus* (Pallas) with notes on transmission routes. Arctic Biological Consultants, Winnipeg, MB for Department of Fisheries and Oceans, Winnipeg, MB. 23 p.

BLACK, G. A. 1983. *Cystidicola farionis* (Nematoda) as an indicator of lake trout (*Salvelinus namaycush*) of Bering ancestry. Can. J. Fish. Aquat. Sci. 40: 2034-2040.

BRUNO, D. W., and T. T. POPPE. 1996. A colour atlas of salmonid diseases. Academic Press, London. xiv + 194 p. *

BUCHWALD, D. G. 1968. The Arctic lamprey of Great Slave Lake, N.W.T. M.Sc. Thesis, Department of Zoology, University of Alberta, Edmonton, AB. ix + 84 p.

CHOUDHURY, A. and T. DICK. 1997. Parasites of broad whitefish (*Coregonus nasus*) from the Mackenzie Delta, p. XX-XX. *In* R.F. Tallman and J.D. Reist (ed.) The proceedings of the broad whitefish workshop: the biology, traditional knowledge and scientific management of broad whitefish in the lower Mackenzie River. Can. Tech. Rep. Fish. Aquat. Sci. 2193 (in press).

DICK, T. A., and L. M. J. BERNIER. 1987. Liver pathology of burbot *Lota lota* (Linnaeus) infected with larvae of the nematode *Raphidascaris acus* (Bloch, 1799) from the Northwest Territories. Prepared for Department of Fisheries and Oceans, Winnipeg, MB. i + 47 p.

DUE, T. T., J. MORDHORST, and A. G. OLSEN. 1991. Investigations on Arctic char (*Salvelinus alpinus* L.) at Igloolik, N.W.T. Arctic Canada, p. 93-144. *In* M. Jørgensen (ed.) Arctic biology course 1989, Igloolik, N.W.T. Canada. Zoologisk Museum, University of Copenhagen, Copenhagen, Denmark.

JAMIESON, J., and R. S. FREEMAN. 1975. Parasitology: parasites of man and of Arctic char at Igloolik, p. 290-293. *In* T.W.M. Cameron and L.W. Billingsley (ed.) Energy flow—its biological dimensions, a summary of the IBP in Canada 1964-1974. Published for the Canadian Committee for the International Biological Programme by the Royal Society of Canada, Ottawa.

MARGOLIS, L., and J. R. ARTHUR. 1979. Synopsis of the parasites of fishes of Canada. Bull. Fish. Res. Board Can. 199: vi + 270 p.

MCDONALD, T. E., and L. MARGOLIS. 1995. Synopsis of the parasites of fishes of Canada: supplement (1978-1993). Can. Spec. Publ. Fish. Aquat. Sci. 122: iv + 265 p.

REIST, J. D., R. A. BODALY, R. J. P. FUDGE, K. J. CASH, and T. V. STEVENS. 1987. External scarring of whitefish, *Coregonus nasus* and *C. clupeaformis* complex, from the western Northwest Territories, Canada. Can. J. Zool. 65: 1230-1239.

SOUTER, B. W., A. G. DWILOW, and K. KNIGHT. 1987. *Renibacterium salmoninarum* in wild Arctic charr *Salvelinus alpinus* and lake trout *S. namaycush* from the Northwest Territories, Canada. Dis. Aquat. Org. 3: 151-154.

SOUTER, B. W., A. G. DWILOW, K. KNIGHT, and T. YAMAMOTO. 1986. Infectious pancreatic necrosis virus in adult Arctic charr *Salvelinus alpinus* (L.), in rivers in the Mackenzie Delta region and Yukon Territory. Can. Tech. Rep. Fish. Aquat. Sci. 1441: iv + 11 p.

STEWART, D. B., and L. M. J. BERNIER. 1988a. An aquatic resource survey of southern Baffin Island, District of Franklin, Northwest Territories. Lands Directorate of Environment Canada and Northern Environment Directorate of Indian and Northern Affairs, Northern Land Use Information Series, Background Report No. 5: vi + 121 p. + map.

STEWART, D. B., and L. M. J. BERNIER. 1988b. An aquatic resource survey of central Baffin Island, District of Franklin, Northwest Territories. Lands Directorate of Environment Canada and Department of Fisheries and Oceans, Northern Land Use Information Series, Background Report No. 8: vi + 129 p. + map.

STEWART, D. B., and P. D. SPARLING. 1987. A biological assessment of Arctic charr stocks in the Kuuk and Kagluk rivers, Victoria Island, NWT, 1987. Inuvik, NWT: Fisheries Joint Management Committee Report 87-001: iv + 43 p.

YAMAMOTO, T. 1989. Infectious pancreatic necrosis virus in Arctic char populations in the Mackenzie Delta region, p. 106-112. *In* W.C. Mackay (ed.) Northern lakes and rivers. University of Alberta, Boreal Institute for Northern Studies, Occasional Paper 22.

FISH NAMES

Fish are often called by different names in different areas. This can lead to confusion about what fish is being discussed. This section lists the accepted North American common name for each species of fish discussed, followed by its Latin scientific name in brackets, and other common names. The french common name is underlined.

Arctic charr (*Salvelinus alpinus*) = char, sea trout, omble chevalier.

Arctic cisco (*Coregonus autumnalis*) = herring, cisco arctique.

Arctic grayling (*Thymallus arcticus*) = grayling, bluefish, ombre arctique.

Arctic lamprey (*Lampetra japonica*) = northern lamprey, lamproie arctique.

broad whitefish (*Coregonus nasus*) = round-nosed whitefish, whitefish, lakefish, river whitefish, corégone tschir.

burbot (*Lota lota*) = freshwater cod, ling, maria, methe, loche, lush, lotte.

inconnu (*Stenodus leucichthys*) = coney, connie, conny, sheefish, inconnu.

lake cisco (*Coregonus artedii*) = cisco, lake herring, tulibee, freshwater herring, cisco de lac.

lake trout (*Salvelinus namaycush*) = lake charr, laker, touladi.

lake whitefish (*Coregonus clupeaformis*) = common whitefish, crooked back,humpbacked whitefish, grand corégone.

least cisco (*Coregonus sardinella*) = lake herring, cisco sardinelle.

longnose sucker (*Catostomus catostomus*) = sturgeon sucker, red sided-sucker, meunier rouge.

northern pike (*Esox lucius*) = pike, northern, jackfish, jack, grand brochet.

round whitefish (*Prosopium cylindraceum*) = ménomini rond.

yellow walleye (*Stizostedion vitreum*) = walleye, pickerel, wall-eyed pike-perch, doré jaune.

ACKNOWLEDGMENTS

Doug Chiperzak of DFO Yellowknife and Dale McGowan of DFO Winnipeg reviewed the manuscript at various stages and were instrumental in its publication. Dale also prepared the map and front cover, arranged laboratory access, and helped see the manuscript through printing. Margaret Keast and Patrice Simon of DFO Iqaluit; George Low of DFO Hay River; and Ken Chang-Kue, Andy Dwilow, Jim Johnson, Herb Lawler, Ole Nielsen, Jim Reist, and Brian Souter of DFO Winnipeg reviewed the manuscript and/or provided photographs or information. Chris Baron, Jim Johnson and Jim Reist provided fish for dissection. Many others also provided welcome advice and materials. We thank all of you for your contributions.